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# THE SCIENTIFIC PRINCIPLES OF OVER-ALL AUTOMATION AND THE PROBLEMS OF ITS DEVELOPMENT

- USSR -

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# THE SCIENTIFIC PRINCIPLES OF OVER-ALL AUTOMATION AND THE PROBLEMS OF ITS DEVELOPMENT

[Following is a translation of an article by V. Solodovnikov (Professor and Doctor of Technical Sciences) and A. Malkin (Economist) in Nauchno-tekhnicheskiye obshchestva SSSR (Scientific and Technical Societies of the USSR), No 6, Moscow 1959, pages 7-9.]

The active participation of innovators, scientists, engineers, and technicians in solving the tasks proposed by the 21st Congress of the CPSU (Communist Party of the Soviet Union) will ensure a mighty increase in socialist production. The leading role in its further improvement belongs to over-all mechanization and automation--the decisive condition for establishing the material-technological base of communism. Discussion of the problems of introducing over-all mechanization and automation at the forthcoming Plenary Session of the Central Committee of the CPSU will be of enormous importance in the successful implementation of the seven-year program.

A production process is required to convert the original raw materials into the finished product in accordance with the accepted technology that satisfies certain technical conditions. Every production process can be considered as a multipolar system in which the so-called material and information lines are to be found.

Information lines are essential for central control of production. Some primary information (the result of observations, measurements, analysis, etc.) is accumulated at the appropriate control point, then processed and used for making decisions as to what action is to be taken on the production process.

Over-all automation requires a high level of development of all the basic technological means for obtaining and using information. The problem of pickups, without which not only over-all, but even partial automation would be impossible, merits special attention. In many cases their absence now retards automation in blast furnace, open-hearth furnace, many chemical and other processes.

The problem of machines which control other machines is another serious problem. At present computer technology has achieved a high level of development, but its application in automatic control is in merely the initial stage of development.

Since the controlling machine must be a unified, mutually interacting system of different mechanisms, the problem of reliability becomes vital. The problems of unification, normalization, and standardization of the means of automation are likewise connected with the controlling machine.

It is essential to create algorithms of control to unify the automated objects into a unified, harmoniously operating system. The term algorithms of control is understood to mean the aggregate of mathematical and logical operations which is employed to process information on the production process in such a way that the process is controlled in accordance with extreme or tolerance values of the indices of technical-economic effectiveness.

A number of difficulties must be overcome in creating algorithms of control. One of them is to derive interconnecting equations, that is, a mathematical description of the process or, in other words, establishing the interdependence of different variables which describe the production process. Thus, for example, it is still not possible to describe mathematically the phenomena in a blast or an open-hearth furnace.

The problem of deriving equations for indices of technical-economic effectiveness has been little studied. Up to the present time more weight has been given the skill and the intuition of the people who control production.

The successful solution of these difficulties will facilitate the accelerated introduction of over-all automation. This will require great creative efforts on the part of scientific and technical personnel in all branches of the national economy.

In the future it will be necessary to develop methods for studying production processes with the objective of describing them mathematically and establishing quantiative relationships between economic and technological factors and introducing statistical methods extensively.

This is also essential because the introduction of automation of production processes has an irregular character at present. Even in the most advanced branches of industry only individual aggregates and technological processes are automated. Work in the field of over-all mechanization and automation of closed cycle production is poorly developed. There are serious obstacles in the limited available inventory and amount of essential machines and mechanisms, and in the unsuitability of existing machinery for automation of: operations connected with the transportation of the products of production, control over technological parameters, changes of tools, etc.

Plans have been made to convert a number of the best-equipped enterprises in the basic branches of the national economy into experimental bases for introducing and testing systems of over-all mechanization and automation during the period 1959-1965. This will ensure the most rapid transition to higher forms of organization of production in whole branches of the national economy.

According to computations, the implementation of the principal measures for mechanization and automation of production processes will cost approximately 120 billion rubles over the seven-year period, while the average annual saving from their introduction will be on the order of 45 billion rubles.

Let us examine some of the basic trends in the development of the most important branches of industry and the problems of qualitative changes in them.

Ferrous and Nonferrous Metallurgy

Over-all automation has not been realized in a single branch of production and only individual units and elements of the technological processes have been automated in the metallurgical industries.

Accelerated development of the mining base is the most important condition for growth of metallurgical production. Automation has been lagging far behind mechanization in mines and ore-benefication plants. At present automatic samplers and devices for regulating pulp density and for discovering metallic objects in nonmetallic minerals prior to crushing are being installed in crushing and sorting plants.

A transition is being made to centralized remote control over conveyer systems and machinery in individual sintering plants, and the delivery of the charge to sintering conveyers is being automated in certain plants.

It is essential to fulfill planning work on the over-all automation of sintering plants, on the mechanization and automation of control over the quality of the raw material and its preparation for sintering, and on the automation of control over the quality of the sintered product.

Over-all automation and installation of control points are to be introduced in 16 crushing and sorting and ore-beneficiation plants, 22 sintering plants, and 17 mines during 1960-1961.

Blast-furnace production in our country is characterized by an uninterrupted increase in the capacity and improved design of blast furnaces, while their production indices and the coefficient of utilization of their useful volume exceed the best results achieved abroad. Regulation of the temperature of the blast and maintenance of constant moisture of the blast, the thermal conditions of hot-air stoves, and the gas pressure under the top have been automated in the overwhelming majority of furnaces. Automatic cars which will eliminate the hard occupation of engine driver are being introduced in the Nizhne-Tagil' and Kuznetsk Metallurgical Combines.

The industrial testing of methods of automatic regulation of the distribution of materials and the flow of gases in the vicinity of blast furnaces, the development of methods for automatic control and regulation of flow of gases along the radius of the shafts, and further improvements in logical action devices (advisers for the master worker) which describe the progress of the melt and in devices for regulating have been planned for 1959-1965.

Important progress has been made in the field of automation of the control and regulation of the operation of open-hearth furnaces. At present all these furnaces have been converted to mechanized charging, while rail delivery of liquid cast iron for charging the furnaces and mechanized collection of slag have become widespread. About three quarters of all steel is poured into ingot molds mounted on cars, and the assembly-line method has been introduced in making up trains of ingot molds.

The alloy steel shops of the metallurgical plants have 66 electric arc furnaces with capacities up to 40 tons; of these furnaces, 52 are equipped with apparatus for overhead charging. All the furnaces are equipped with automatic power regulators and automatic electrode changers. The first models of devices for the electromagnetic stirring of electric furnace baths are now being mastered.

The over-all automation of the melting processes in electric arc furnaces is now being worked out. Devices for continuous pouring of steel are making possible a significant increase in output and decreased production costs. Eight electric furnaces of the vertical or overhead type with immovable and movable crystallizers, and with batch or continuous mixing facilities are in operation.

The creation of plans for fully automatic control over a steel-making furnace which will decrease the participation of the steel melter in the course of the melt is a further step forward.

Plans have been made to equip, with complex devices for automatic heat regulation, 72 furnaces which are to be built and 105 large existing furnaces, 23 converters with overhead oxygen blast, and all facilities for continuous steel pouring, during the period 1959-1965. Introduction of these facilities will mean automatic delivery of fuel to furnaces, automatic control of valves, and automatic control of oxygen blasts through the baths.

The Soviet rolling industry has been supplied with a significant quantity of highly mechanized rolling mills. Thirty-five newly installed rolling mills are distinguished by high-speed rolling. Automation of blooming mills has been introduced in the Kuznetsk and Magnitogorsk Metallurgical Combines. In a number of blooming mills the control of rolling equipment, receiving and rolling conveyers, and other machinery has been automated.

An electronic digital computer was used for the first time to automate the rolling mechanism of a type-900 blooming mill.

The Seven-Year Plan for the Development of the National Economy of the USSR provides for raising the level of mechanization and automation of technological processes in the basic branches of ferrous and nonferrous metallurgy up to 80 percent and for automating 250 units in the mining industry, 114 blast furnaces, 177 open-hearth furnaces, 45 rolling mills, etc.

Petroleum Industry

Our country has made significant progress in the automation of oil refining and oil extraction. Control over the general technical parameters has already been automated, and automatic regulation of desalting and atmospheric-vacuum distillation of petroleum, thermal and catalytic cracking, removal of sulfur, etc., has been widely introduced. Plans have been made to carry out, during the period 1959-1965, over-all automation in three existing oil refineries and in five now under construction, the automation of commercial and raw materials warehouses on the premises of two oil refineries, and the over-all automation and remote control of 15 oil pipelines and 20 gas pipelines.

The automation and remote control should include the most complete technological cycle of oil extraction, ending with production accounting and pumping it into pipelines with quantities indicated by figure printing machines.

Chemical Industry

The exceptional variety of technological processes and the presence of specific difficulties have led to irregular development in the automation of different branches of the chemical industry. The production of instruments and automatic devices for controlling and regulating different aggressive chemicals, devices for handling explosive agents, and devices for high pressures, etc., is particularly unsatisfactory.

Various degrees of automation in processes of contact decomposition, the condensation and rectification of alcohol, the absorption and separation of 1, 3-butadiene, "dessterisnevoy" [meaning of term not known] polymerization, and a number of others have been achieved in most synthetic rubber and synthetic alcohol plants.

In four synthetic alcohol plants which have been put into operation in the last few years, automation has been achieved on an over-all level, which has resulted in a sharp increase in productivity.

The production of synthetic acetic acid and caprolactam has been automated to a significant degree in organic synthesis plants, and the entire technological process is controlled from a central control panel.

In the industrial rubber products industry and the tire industry, the unloading and selection of rubber from rubber mixers, the process of vulcanization, the selection of beads, and the calibration of rubberized cord have been automated. Continuous thermoplasticizing has been put into operation in individual plants, and the very laborious process of assembling truck tires has been mechanized.

Plans have been made to work on automation of processes in all the basic branches of the chemical industry in the period 1959-1965. Thus, for example, the production of synthetic ammonia from natural gases, nitric acid, ammonium nitrate, etc., should be fully automated.

The application of television and computers is specified in these projects with the objective of creating rational layouts for an automated nitrogen plant with a minimum of production personnel.

Power Engineering

The use of district heating plants, that is, the combined production of electrical and thermal energy in central heat and electric power plants, is a special feature of power engineering in the USSR. The level of automation of many processes in the operation of electric power stations and power systems is just as high as it is in the most advanced capitalist countries. Protective relays operate properly about 99 percent of the time here, which does not occur in any capitalist nation. A significant simplification of the protective relays and improvement in their operation have made possible the wide use, in power systems, of automatic reclosing (APV) and automatic switching on of standby equipment (AVR) and also of high-speed regulation of excitation of synchronous

machines. However, we observe that we are now lagging behind the most advanced capitalist countries in designing protective relay apparatus with semiconductor devices and other new items in instrumentation.

The measures taken in recent years to introduce equipment for automation have markedly increased the reliability of operation of our power systems. These measures, which have become very widespread, include automatic regulation and forced excitation of all synchronous generators and compensators, and also of synchronous motors, automatic starters for important electric motors which serve the internal needs of electric power stations and industrial enterprises, automatic reclosing of lines, and a number of others.

The most highly perfected system of the so-called forced regulation of excitation which ensures the stability of parallel operation of electric power stations which are distant from each other has been put into effect at the Kuybyshev Hydroelectric Power Station. It is necessary to devote special attention to the wide introduction of this effective means in connection with the unified power system.

The power systems of the USSR are lagging in the use of automatic devices which ensure the required quality of electric power. Thus, the voltage is automatically regulated on a large scale only at the generators and synchronous compensators and rarely in the distribution networks. The latter fact is explained by the low output of transformers with voltage regulation under load.

Soviet equipment connected with high-frequency telephone channels, protective devices and telemechanical devices on electric power transmission lines is on a high technical level. However, our electric power systems are lagging in the application of radio relay lines. In addition to finding solutions to the problems enumerated above, the Seven-Year Plan calls for ensuring the further development and improvement of communications channels and telemechanics in the power systems and, in particular, UHF radio communications with radio relay lines.

Machine Manufacture

The technical level of the entire national economy depends on the development of this branch of industry. The machine manufacturing industry is developing along the lines of introducing automated assembly lines for the production of individual products. However, during the last seven years, only 6.3 percent of the machine tools produced were automatic and semiautomatic while only 1,440 machine tools are working on automated lines, that is, about 0.05 percent of the total number. About five million persons are attending metal-cutting machine tools in our industry.

Automatic lines based on combining forging-pressing and bending machinery are very effective in manufacturing metal articles and parts for the electrical engineering and radio engineering industries. Automatic lines for assembling operations are less widespread.

In recent years more than 50 automatic lines made up of aggregates of machine tools have been established. The establishment of automatic lines for machining the cylinder blocks of GAZ-51 engines has permitted raising labor productivity by 2 to 4 times; for the manufacture of relay springs, by 7-8 times; and for the production of Hall chains in the Kiev Plant and watch parts in the Second Moscow Watch plant, by 9-10 times.

Plans have been made to put a number of measures into effect in the period 1959-1965: to establish not less than ten automatic plants for producing parts and assemblies for automotive and tractor plants, to convert advanced enterprises to model automated and mechanized production with the application of centralized control systems, and to ensure the extensive introduction of automated assembly lines.

The commissioning of at least 4,000 automated assembly lines and at least 160,000 new universal aggregates and multiposition machine tools is projected with this objective.

The mechanization and automation of manufacturing processes with removal of chips are of great economic significance in machine manufacture. In this connection the introduction of metalworking machine tools operating under programmed control is of particular urgency.

The Seven-Year Plan provides for raising the level of mechanization and automation to an average of 60 to 70 percent, at the same time ensuring an increase in labor productivity of 60 percent.

Scientific-technical societies, as the mass organizations which unite locally wide circles of highly skilled specialists and workers -- production innovators -- will play a large part in developing and carrying out measures to introduce over-all mechanization and automation. Every board of administration should have a scientific-technical plan for solving urgent problems in the automation of production.

For example, about a million persons are working in the operational control of the output of the machine manufacturing industry and more than 20,000 persons are occupied in performing merely such operations as analysis in the chemical industry. If the societies concerned were to run contests for introducing automatic control devices, this would mean elimination of manual labor, improvment of working conditions, and increased labor productivity.

Organizations of scientific-technical mining societies can render aid in the development of automation in coal-sorting plants of the coal mining industry, which would permit discharging 50,000 persons and raise the production per production worker by 2.5 to 3 times.

The scientific-technical society of the instrumentation industry can be of great help in the work of successful development and introduction of control machines and automatic control systems into industry. It would be expedient for the society to hold a conference on the application of computer techniques and the further development of automation.

The scientific-technical society of the power industry should be more active in solving such problems as that of the introduction of devices for automatic frequency regulation and power distribution. It is essential to coordinate the application of these devices more closely with the over-all automation of electric power stations.

The other scientific-technical societies are faced with no less vital problems. In the field of automation their activities are really unbounded. They should cooperate more widely to develop creative initiative in the societies' members in the struggle for technical progress.

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